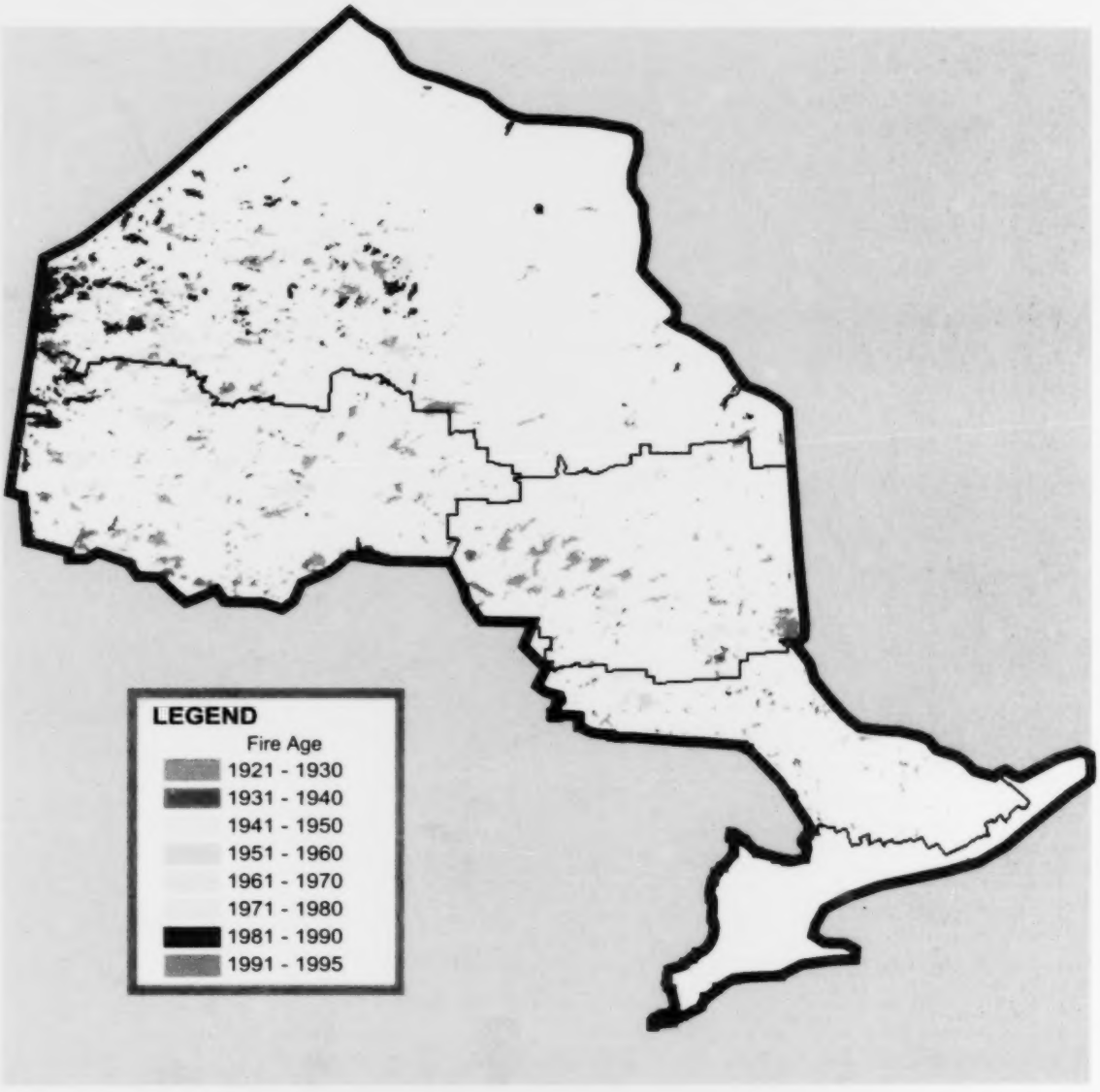
Forest Research Report No. 147

Ontario

Forest Fires in Ontario:

A Spatio-temporal Perspective



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Forest Fires in Ontario:
A Spatio-temporal Perspective

by

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1998

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Abstract

Forest fires are of considerable ecological, economic and social importance in Ontario. Knowledge of forest fire regimes is essential for policy development for fire management, timber harvesting, and of late, sustainable forest management. We have developed a CD-ROM-based digital atlas of the forest fire history of Ontario to provide information about past fire regimes. This report describes the methods used in developing the GIS database of fire history and the systems architecture of the software package. In addition, we provide a description of the range of capabilities of the fire history atlas for querying and analyzing spatio-temporal fire information with examples and a users guide.

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INTRODUCTION

Background

Fires are a natural and intrinsic component of Ontario's forest landscapes; a frequent occurrence in both the boreal and Great Lakes-St. Lawrence biomes. From a socio-economic perspective forest fires are a destructive force. Therefore, forest fire management, primarily focused on fire prevention and control, has been an important topic in Ontario's forest policies for over 100 years. From an ecological perspective, periodic forest fires trigger changes in species composition and structure, and, in interaction with geo-climate, create a shifting mosaic of forest spatial patterns. The realization that forest fires are an integral part of northern forest landscapes has spawned a new attitude: understand the nature of forest fire disturbances in order to understand how forest ecosystems function.

Using knowledge of forest fires in the management of forests can range from mimicking or emulating the disturbances to using the bounds of natural variation in fire disturbances as a guide. For example, emulating fire disturbances with forest harvest patterns was a heavily debated topic during the recently concluded environmental assessment hearings in Ontario. The less direct approach of using bounds of natural variation in forest fire regime patterns as extremes of forest harvest patterns is now a base for developing environmental guidelines for Ontario's forest management practices.

Understanding the nature of forest fires can be done at many ecological scales, ranging from the small spatio-temporal scale of the floor of a forest stand to the very large spatio-temporal scale of the continent. Understanding fire at large spatial extents and multi-year temporal intervals is necessary for a provincial or even regional perspective. This is important for policy development and land use planning, as well as for the forest fire management efforts that cost over $75 million annually. Location, eventual size, spatial boundaries, and associated geo-climatic conditions of forest fires provide valuable information for the planning and policy development process, as well as for researchers trying to understand fire behaviour.

Forest Fire Information

We have developed a CD-ROM-based digital atlas of Ontario's forest fire history, that provides information about spatial characteristics of fires between 1920 and 1995. In this atlas, the province is divided into 3 zones that reflect the forest fire control history and present fire control policies. The zone of southern Ontario (below 46^0 N) has been, and continues to be, the focus of intense fire control because of the high population density. Fire control activities in the zone of extensive forest management (from 46^0 N to 52^0 N) have increased in intensity with time, especially since the 1950s. In contrast, far northern Ontario (above 52^0 N) reflects low intensity fire control and consequently, most fires are left to take their natural course. The atlas includes information on location, year of event, and polygon characteristics of each forest fire, geo-referenced and stratified by various spatial templates such as standard map sheets, ecological regions, and forest management units. The atlas is integrated with a interactive display and spatial analysis capabilities, including imaging, browsing, querying, and analytical facilities with geo-spatial accuracy. The atlas provides a ready source of fire history information to novices and professional alike.

This report provides a description of the methods used to develop the spatio-temporal database of forest fires, an overview of analytical capabilities in the atlas, and a user's guide for the atlas.

METHODS

Data Sources

The digital data on wildfire in Ontario originated from 3 sources. The first source was hardcopy maps, produced by Donnelly and Harrington (1978), that were based on information collated by the Ontario Ministry of Natural Resources (OMNR) between 1921 and 1976, from aerial photographs and fly-over information after fires. The second source was information collated by the Aviation, Flood, and Fire Management Branch of the OMNR, again on hard copy maps, covering the period 1976 to 1995. These maps were also largely based on aerial photographs and post-fire fly-overs. The third source of information was classified (supervised) Landsat Thematic Mapper (TM) and Multi-spectral Scanner (MSS) imagery for the period 1973 to 1991 (Spectranalysis 1994). The MSS and TM data included digital (1987-1991), transparency (1977-1978), and hardcopy (1973-1981) forms.

Database Preparation

We digitized all hardcopy maps (OMNR and Donnelly and Harrington 1978) into Transverse Mercator Projection using SPANS ™ and Arc/Info™ software at a final resolution of 1 ha pixel size. These 2 sources provided a continuous digital database for fires from 1921 to 1995. The Landsat (TM and MSS) data, re-sampled to 1 ha, was added to this database, providing supplementary information for the period 1955 to 1991.

Spatial Scope of the Data

Data resolution varied among the sources. The maps from Donnelly and Harrington (1978) were produced at 1:500,000 scale and the OMNR maps were a mixture of 1:250,000 and 1:500,000 scales. The Landsat imagery varied in resolution, from 80 m x 80 m pixel size for MSS data to 30 m x 30 m pixel size for TM data. Because the Donnelly and Harrington (1978) maps contained only forest fires over 200 ha we did not include smaller fires in the database, even though the other data sources contained information on smaller fires. However there are instances where fires appear smaller (relatively) than 200 ha in the database. This happens when the recorded fire has slivers that are disjunct from the main body, but are considered to be one fire by the data compilers. The other instance where reported fires can be smaller than 200 ha occurs due to spatial rounding off and digitizing errors. In those cases, the fires are very close to 200 ha. A fire polygon in our database is the area bounded by the outside perimeter of the fire. Residual (unburned) vegetation inside the perimeter of the burn was not identified. Given the methods used to collate original information, inclusion of residual areas is beyond the scope of the database. Water bodies inside the fire areas are included in displays, but can be optionally excluded from spatial analyses. Also, only *stand-destroying* fires were included.

Temporal Scope of the Data

The temporal scope of the database varies by zone in the province (Figure 1). The information in Zone 1 is not comprehensive until after 1975, because the far north and Hudson Bay Lowlands were not included in the Donnelly and Harrington (1978) maps. The few pre-1974 fires that were included were derived from Landsat imagery, and these too were limited to the lower part of Zone 1. After 1975, the data are continuous. Fire information for Zone 2 is temporally comprehensive from 1921 to 1995, while Zone 3 fire information is continuous from 1921 to 1976. We did not update this zone using Landsat imagery or OMNR fire maps because of the extreme rarity of large fire events. The time of each fire event is noted by the calendar year, even though actual dates were available in most instances.

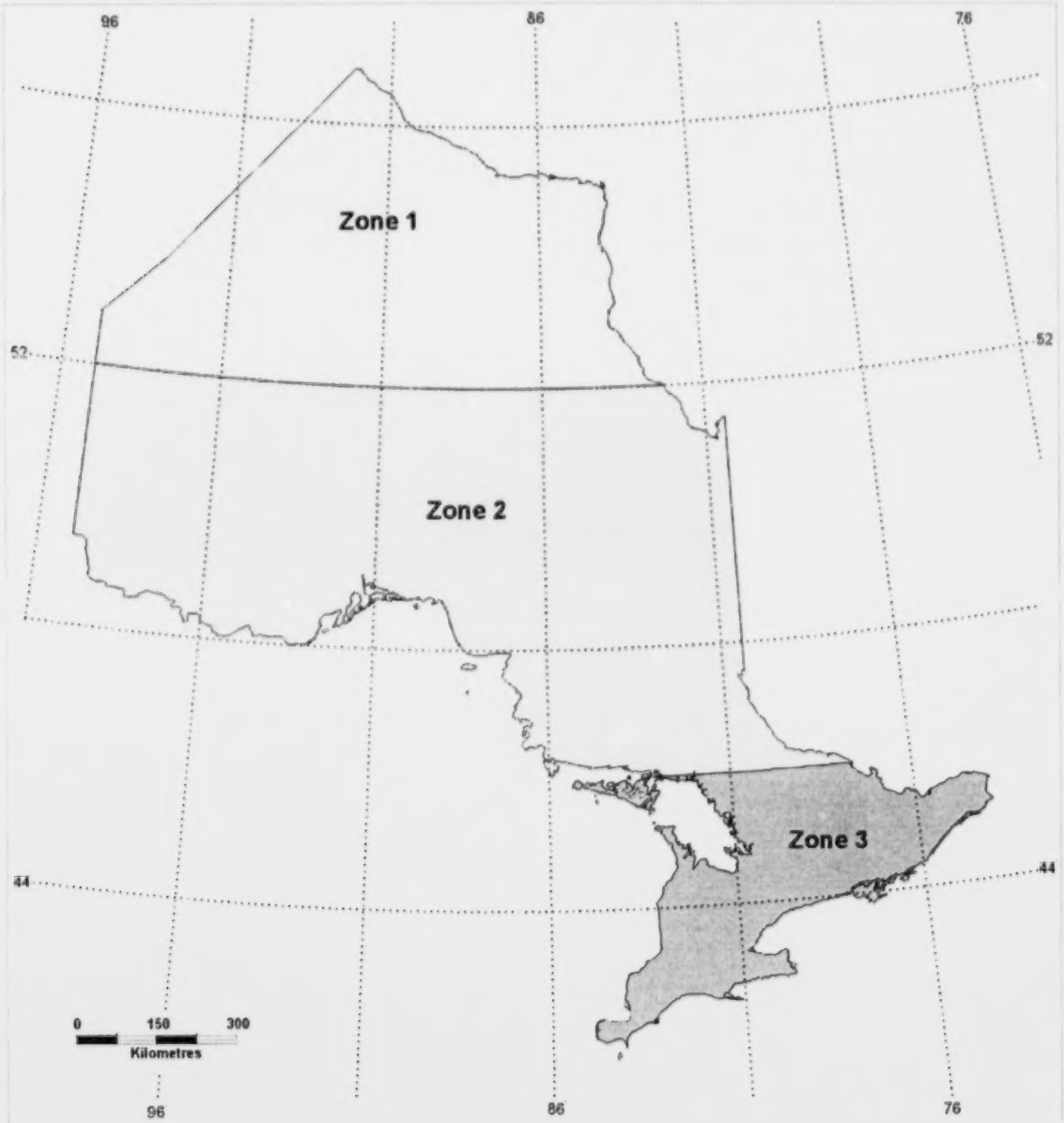


Figure 1. *The 3 zones of forest fire history in the database.*

Accuracy of the Data

The accuracy of this database has 2 dimensions: the temporal accuracy of the fire events, and the spatial accuracy of individual fire scars. With the hard copy map sources, the temporal accuracy of fire events is very high. However, the crude mapping (non-GPS) of the fire perimeters, especially for older fires, may have introduced inaccuracies in the fire polygon area delineation. To correct this problem, and also to verify the mapped fires, we used Landsat imagery. We overlaid the 2 databases giving precedence to the digitized map database with respect to the time of fires (decade) and to the satellite database with respect to the boundary of fires in cases of conflicts (Table 1). This procedure was possible only for the fires within the last 4 decades (1950s - 1980s). Subsequently, we did a ground-level corroboration for discrepancies by contacting OMNR field staff to verify fire locations and times. Where evidence of disturbance was questionable, and could not be corroborated by a secondary source, those fire polygons were omitted from the database.

Geographical Templates

We have incorporated several spatial templates to facilitate the use of the fire history database. The templates can be used for geographical positioning while displaying maps, as well as for stratifying the database during spatial analyses and queries.

- The nested hierarchy of **Hills ecological classification system** (Figure 2), which is widely used in the province of Ontario, is the main ecological template. Since its development, numerous adaptations and modifications have been put forward, but we chose to use the original version of site regions and site districts (Hills 1959).
- Administrative templates of **OMNR administrative regions** (Figure 3) and the **forest management units** (Figure 4) relate fire information to OMNR management structure. These administrative boundaries were the OMNR's official working units at the time this database was developed.
- The **National Topographic Survey** (NTS) **map sheet series** of 1:250,000 (Figure 5) is a way of using fire history data in conjunction with other spatial databases.
- The **surficial geology map of Ontario** (Figure 6) is used to facilitate analyses of fire patterns based on substrate. For this purpose, we used the surficial geology digital atlas for Ontario (Perera et al. 1996).

Table 1. *Data sources used to create the unified digital fire history database.*

Data Source	Scale	Reference	Temporal Scope	Spatial Scope	Precedence
Hard copy maps	1:500,000	Donnelly and Harrington (1978)	1921 - 1976	Zone 2 and Zone 3	Temporal
Hard copy maps	1:500,000 !:250,000	Ontario Ministry of Natural Resources	1976 - 1995	Zone 1 and Zone 2	Temporal
Landsat Imagery TM and MSS	80 m x 80 m and 30 m x 30 m	Spectranalysis (1994)	1955 - 1991	Zone 1 (part) and Zone 2	Spatial

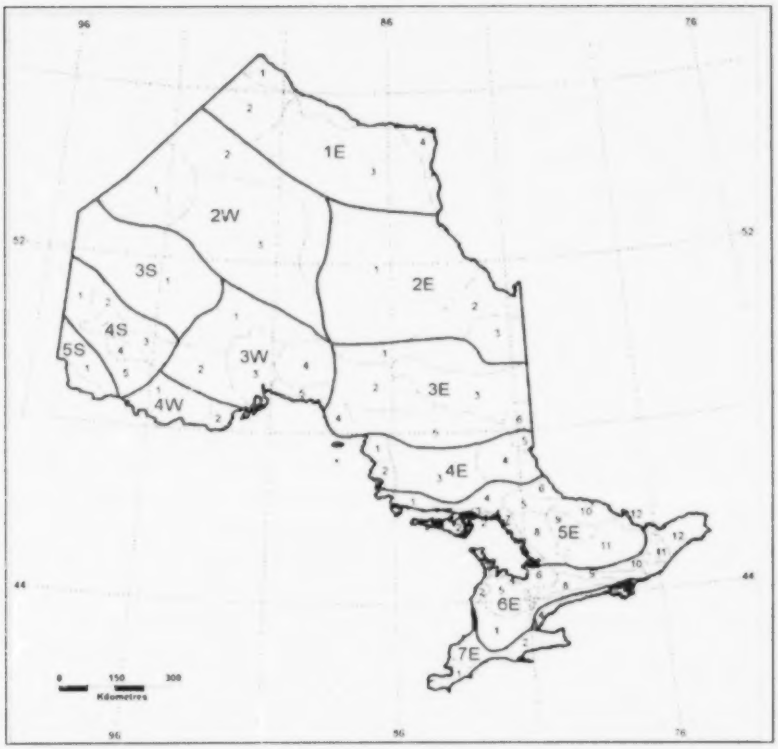


Figure 2.

Hills (1959) ecological land classification system template for Ontario.

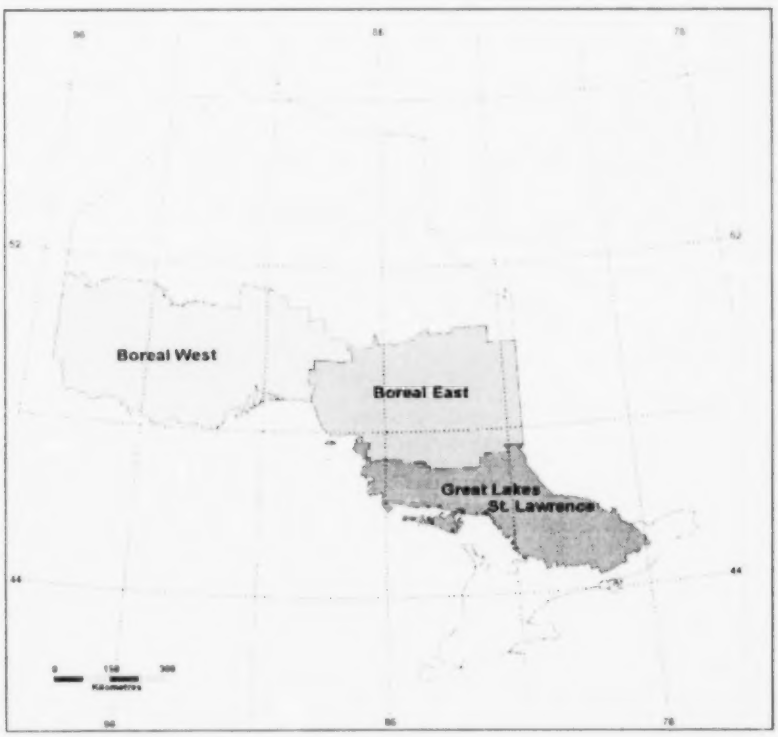


Figure 3.

Ontario Ministry of Natural Resources administrative regions template.

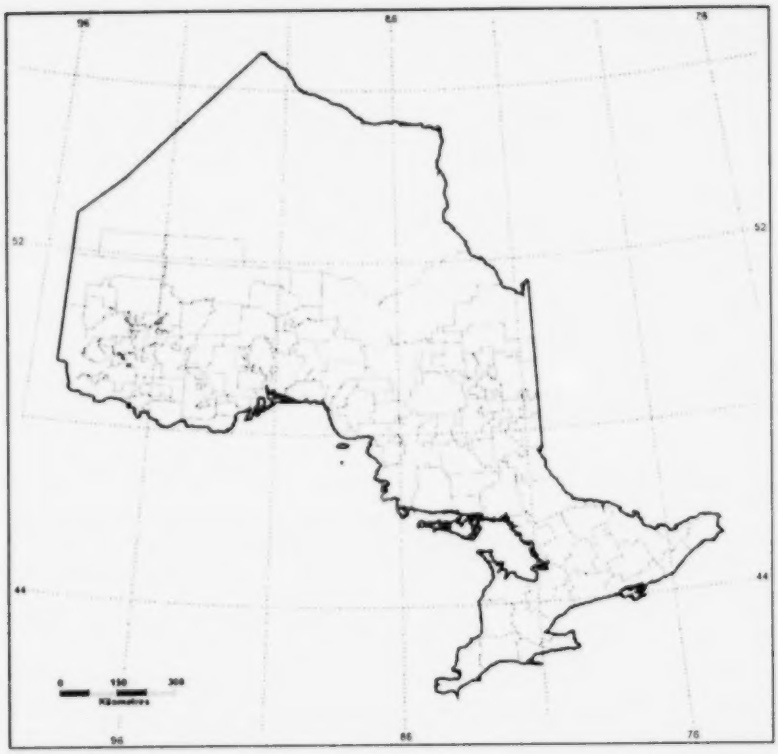


Figure 4.

Ontario Ministry of Natural Resources forest management unit template.

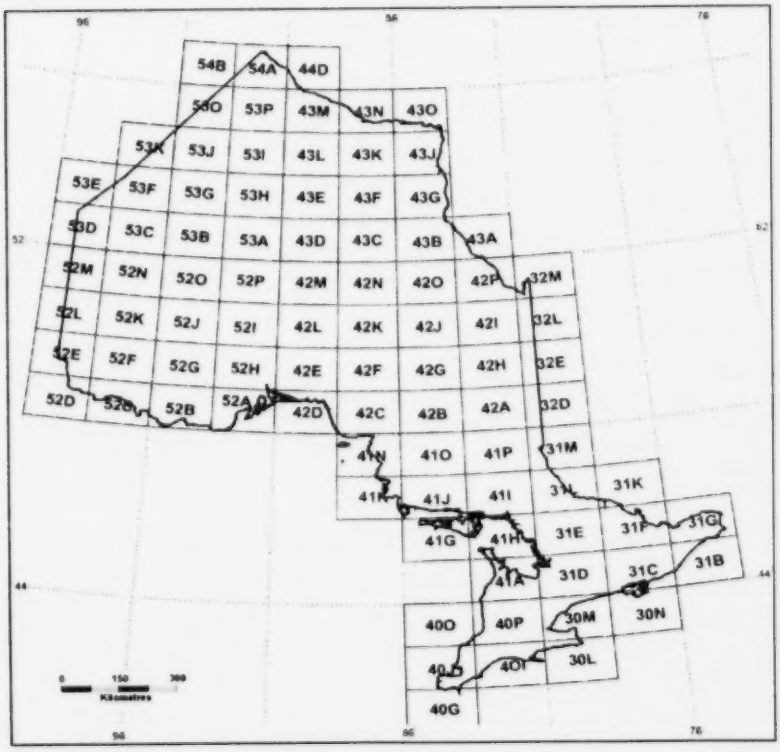


Figure 5.

National Topographic Series of Canada 1:250,000 template.

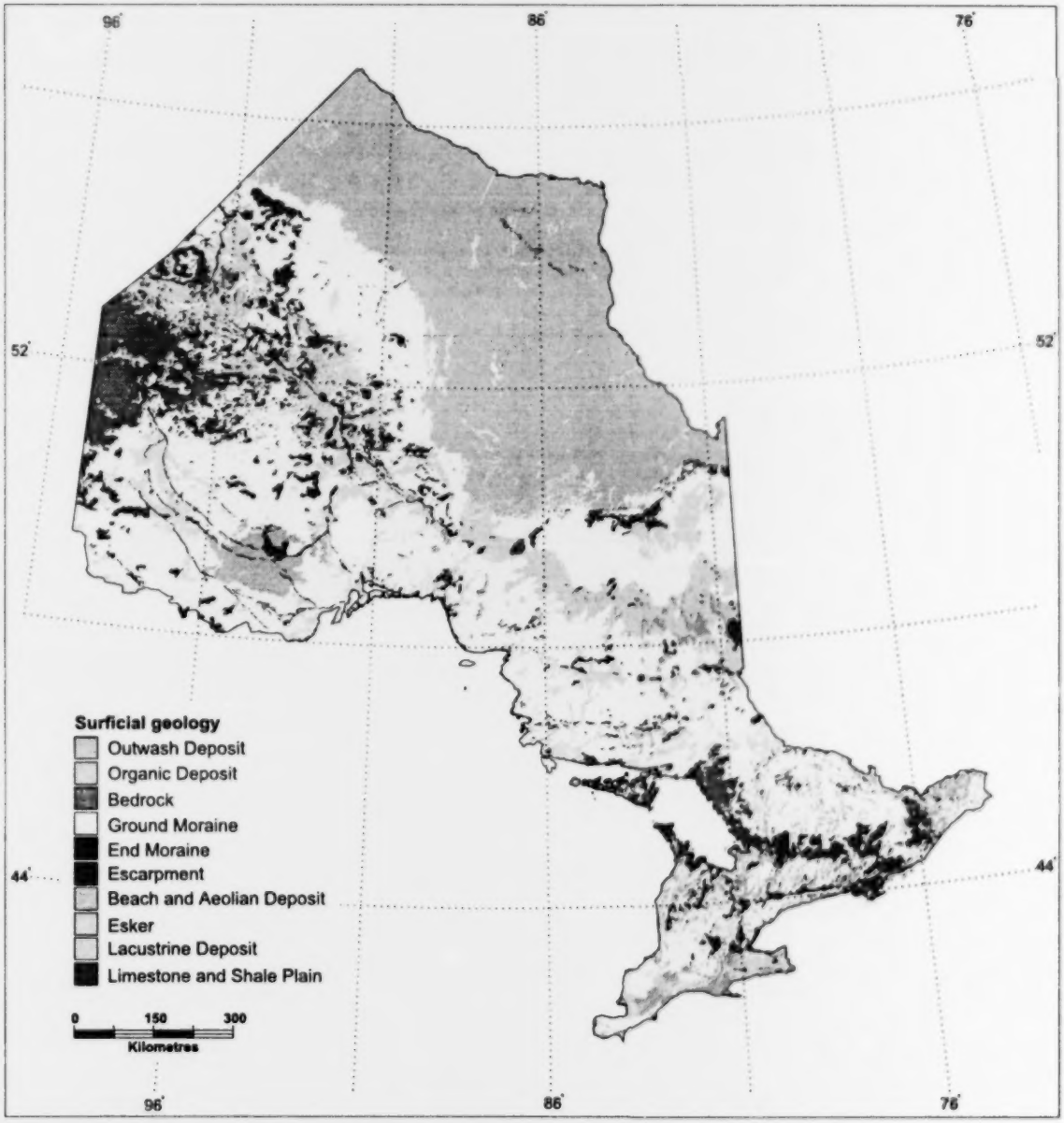


Figure 6. *Generalized surficial geology classes of Ontario (Perera et al. 1996) template.*

Spatial Data Structure

Fire data were translated from Arc/Info coverages into a Shapefile, in which each fire is represented by one or more polygons. Where a fire is not bisected by the boundaries of any spatial templates, it is stored as a single polygon. Where a fire is bisected by the boundary of a single template (e.g., Hills Site District), the 2 resulting polygons are stored separately. A fire bisected by 2 or more templates is represented by several polygons. The motivation for this data structure was the desire to have data summaries for units and districts that include only those portions of fires that fall within them. Hence, for example, if a fire spans the border of a management unit, the area summary for the unit includes only the portion of the fire falling within it.

This same approach is applied temporally. Where 2 fires of different years overlap, the fires are represented by 3 polygons: one for the area of overlap, and 2 for the areas unique to each fire. Thus, we can determine the area of each fire separately while still maintaining a single layer of spatial data (i.e., a single Shapefile).

Attribute Data Structure

The fire polygons stored in the Shapefile contain only 1 attribute: a polygon index number that uniquely identifies each polygon. All attribute information is stored in a Microsoft Access ™ database. The attributes for each polygon are stored in the Polygon Attribute Table, which includes:

- polygon ID number (providing a link to the spatial data)
- polygon area
- Hills Site District
- forest management unit
- NTS map sheet

The last 3 attributes indicate the geographic location of each polygon in terms of district, unit and map sheet. Because polygons are formed by the bisection of fires by these spatial templates, a polygon always falls entirely within a single district, unit and map sheet.

Each polygon is part of 1 or more fires (a polygon is part of more than 1 fire only where it is the area of overlap of 2 or more fires of different years). This relationship is maintained in the Polygon-Fire table, which identifies the fire(s) a polygon belongs to, and contains just 2 fields:

- polygon ID number
- fire ID number (uniquely identifies each fire)

Information about each fire is stored in the Fire Attribute table, which includes:

- fire ID number
- fire year
- fire decade
- fire area
- fire perimeter
- Hills Site Region

Together, the Polygon Attribute, Polygon-Fire, and Fire Attribute tables form a relational database. Data summaries are generated through SQL queries on the database. The form of each query depends on the type of summary the user requests. This dynamic approach allows the user to generate a vast array of different summaries and analyses, tailored to their specific requirements. It also allows us to update or modify the database without having to modify the program code that generates the summary analyses.

The Hills Site Region attribute is stored in the Fire Attribute table, rather than in the Polygon Attribute table with the other spatial template attributes. Unlike units, districts, or map sheets, site region boundaries are not used to bisect fires. Where a fire falls on a regional boundary, the entire fire (its total area) is assigned to the region that contains the largest portion of the fire.

Note that the fire area attribute in the Fire Attribute table is redundant, since the area of a fire can be calculated from the area of its component polygons, given in the Polygon Attribute table. However, the performance of

queries on whole fires is improved by having the fire area stored in the database, rather than calculating it at run-time.

Programming

A number of different programming tools were used in the development of the fire history atlas. Our aim was to design an intuitive, easy-to-use program consistent with general Windows ™ applications. The interface, which includes the menus, display and selection windows, and dialog boxes, is written in Visual Basic ™. The SQL queries that are used to interrogate the database are also written in Visual Basic. Each request for a table or chart summary results in a query to the database. The query is constructed at run-time by the program, based on the user's current selection of decades or years, geographic area, and type of summary. Once constructed, the query is processed by the Jet database engine, which returns a record set containing the summary results. The record set is translated into a table or chart for display. All analysis and processing is transparent to the user; no knowledge of SQL or relational databases is required.

Spatial display of the data is managed through MapObjects LT ™. This add-in component from ESRI ™ permits the display of the Shapefile using procedural calls from Visual Basic. MapObjects LT provides the basic viewing functionality, including image zooming, scrolling, and panning.

GIS Data Library

The spatial data, including fire data and spatial templates that are accessed by the atlas, are stored in Shapefiles. The fire and spatial template data are also provided in the form of Arc/Info coverages. Although not used directly by the program, users may find this data useful for further, more detailed analyses using Arc/Info. The directories on the distribution CD-ROM containing these files are outlined in Appendix I.

SPATIO-TEMPORAL ANALYSIS OF FIRE HISTORY

In this section, we describe some of the spatio-temporal analytical capabilities of the fire history atlas. The analytical steps and results detailed here cover only a fraction of the complete capabilities of this interactive spatial software.

Basis for Spatial Analyses

The fire history of Ontario can be investigated based on the 3 zones (Figure 1) that reflect past and present fire control activities. All 3 zones have spatial templates that enable sub-zonal spatial analyses. Some sub-zonal templates have second-order templates nested within them. Table 2 illustrates the various sub-zonal templates used in the fire history database.

These templates are used to intersect the fire polygons, and provide map displays and summaries of the characteristics of fire events.

Basis for Temporal Analyses

As mentioned earlier, the temporal scope of the overall fire history database ranges from 1921 to 1995. However, Zone 1 contains data from only 1976 to 1995; Zone 2 from 1921 to 1995; and Zone 3 from only 1921 to 1976. In any zone, or other spatial template, fire history can be analyzed either by individual year, a range of years, or decades.

Browsing Fire History Data

Geo-referenced maps of spatial distribution of fires and characteristics of individual fire events can be displayed interactively, either with or without a spatial template. For example, Figure 7 illustrates the spatial distribution of fires in Zone 2 for the period 1921 to 1995, categorized by decade, with the forest management unit

Table 2. *Sub-zonal spatial templates available for analyzing fire history data.*

	First-order Sub-zonal Template	Second-order Sub-zonal Template
Zone 1 (above 52°N)	Hills Site Regions	Hills Site Districts
		Management Units
	Management Units*	-
	NTS Map Sheets	-
Zone 2 (from 46°N to 52°N)	Hills Site Regions	Hills Site Districts
		Management Units
	OMNR Planning Regions	-
	Management Units	-
	NTS Map Sheets	-
Zone 3 (below 46°N)	Hills Site Regions	Hills Site Districts
		Management Units
	OMNR Planning Regions	-
	Management Units	-
	NTS Map Sheets	-

*Only applicable to the southern part of the zone

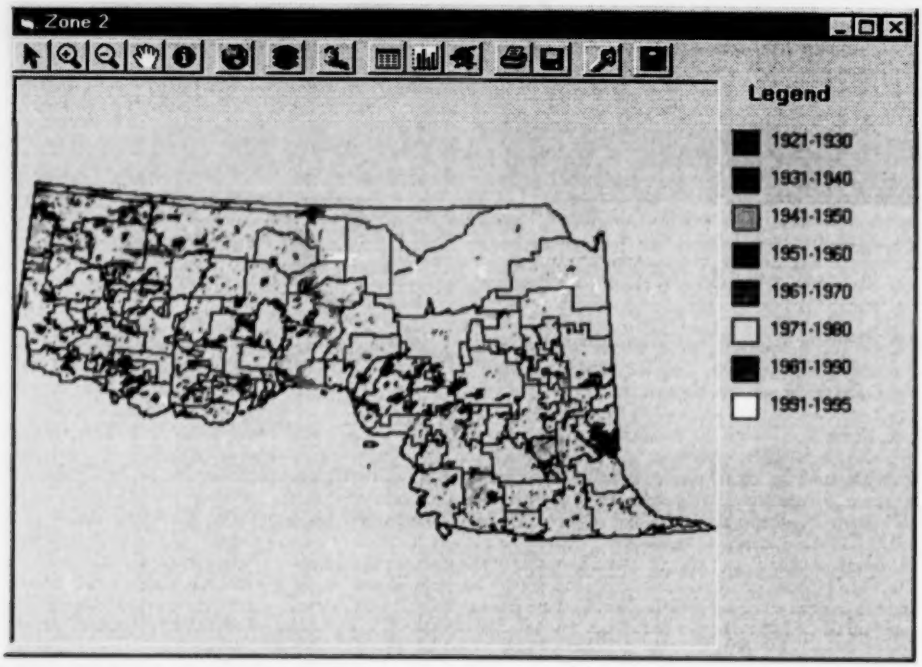


Figure 7. *The spatial distribution of fires in Zone 2, categorized by decade, for the period 1921 to 1995, overlain by forest management units.*

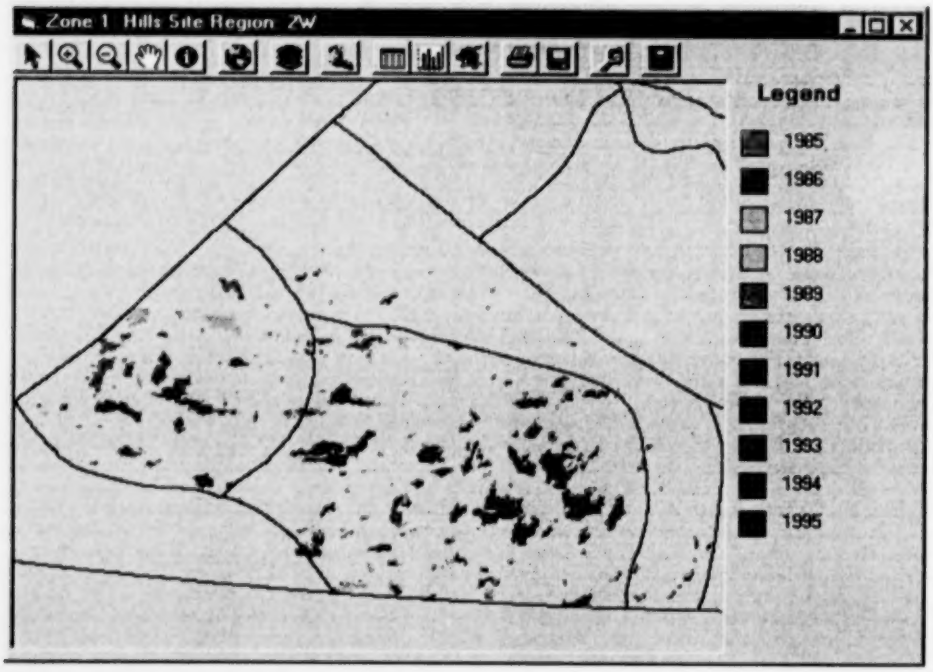


Figure 8. *The spatial distribution of all fires between 1985 and 1995 in Hills Site Region 2W of Zone 1, overlain by Hills Site Districts.*

template. Figure 8 illustrates the spatial distribution of fires for the years 1985 to 1995, in Hills Site Region 2W of Zone 1, with the Hills Site District template.

In addition to browsing the spatial distribution of fires, individual characteristics of a single fire can be displayed (Figure 9).

The ability to remove lakes and other water bodies from fire polygons during area calculations can be useful, and in some instances important. Figure 10 shows a large fire that contains a substantial area of internal water bodies.

Analyzing and Querying Fire History

The most interesting and informative aspects of fire history are its spatial and temporal patterns. Using the spatial templates described previously, and the user-defined temporal ranges, patterns in fire history can be queried and analyzed in numerous ways. First, fire number, fire area, and the total perimeter (edge) of all fire events can be assessed and reported based on the spatio-temporal boundaries. Second, fire events can be analyzed by fire size classes, set interactively by the user. Third, the percentage of area disturbed by fires can be assessed either for individual periods of years, or cumulatively over a range of years.

Fire Information Summaries

Fire information can be summarized for any zonal or sub-zonal area and temporal range. The number of fires and the total area burned (including re-burns) can be extracted with mean fire size values. The total edge created by fire events is calculated as the sum total of all fire event perimeters, including those repeated in the same space. For example, Table 3 shows the fire information summary for all of Zone 2, from 1921 to 1995, by decade. Figure 11 shows the number and area of fires for Site Region 3E in Zone 2, from 1941 to 1980, by decade.

Table 3. *Number of fire events, total fire area, mean fire size, and the total edge of fire polygons in Zone 2 for the period 1921 to 1995, by decade.*

Decade	Number	Area (ha)	Mean Area (ha)	Edge (m)
1921-1930	520	2,091,556.7	4,022.2	12,670,340.9
1931-1940	453	1,292,087.0	2,852.3	9,856,638.4
1941-1950	247	1,135,748.0	4,598.2	6,471,971.5
1951-1960	138	533,361.1	3,864.9	4,376,316.1
1961-1970	105	715,070.8	6,81.2	5,110,185.7
1971-1980	242	887,947.1	3,669.2	7,238,982.1
1981-1990	186	651,806.8	3,504.3	5,698,771.9
1991-1995	101	459,828.3	4,552.8	6,734,956.3

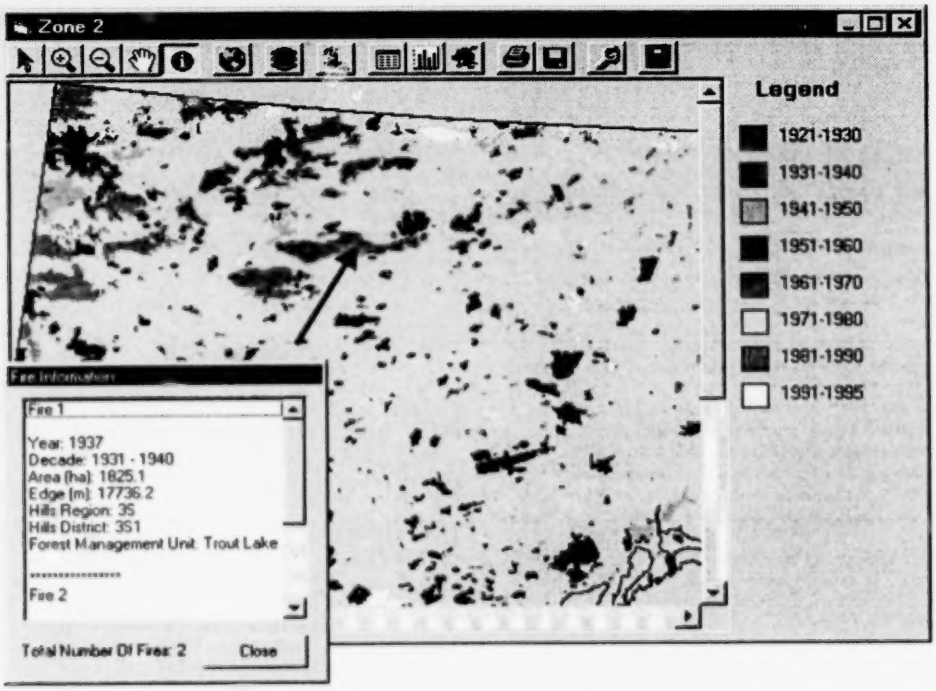


Figure 9. *Details of individual fire polygons in the forest fire history database.*

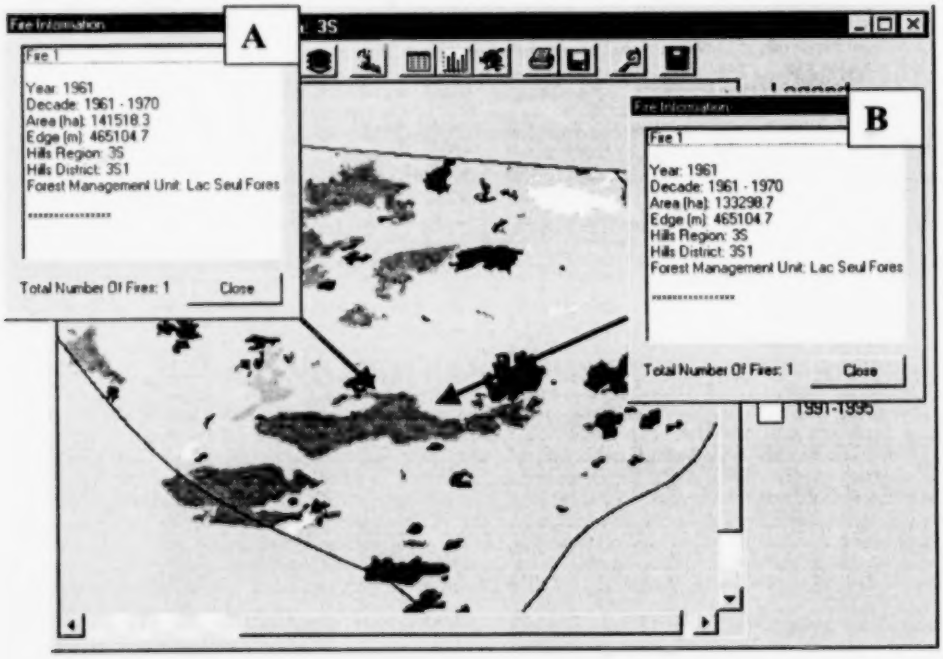


Figure 10. *The effect of internal water bodies on forest fire area a) with area of water bodies, and b) without area of water bodies.*

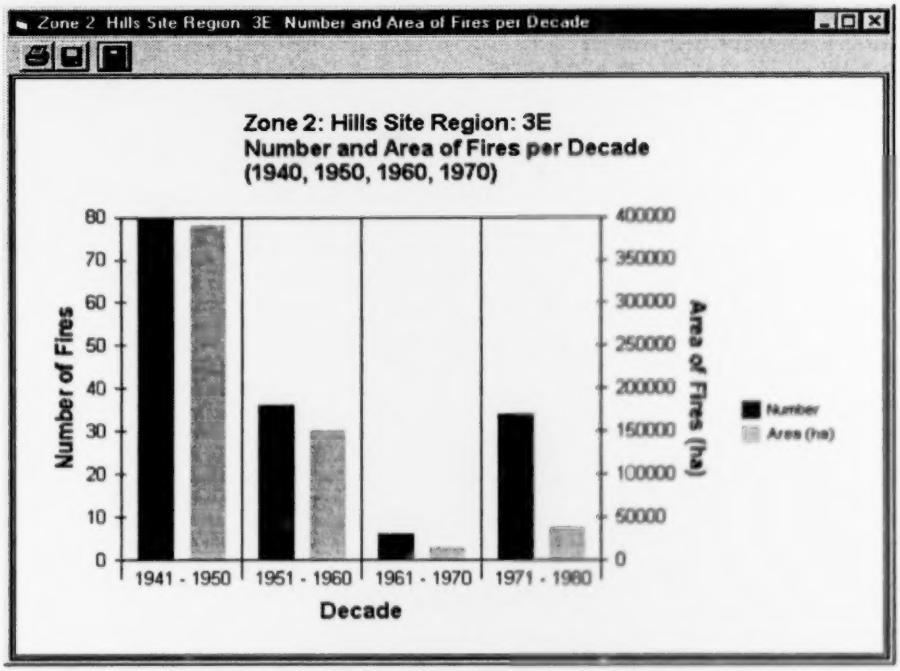


Figure 11. *Total number and area of fires for Hills Site Region 3E in Zone 2, for the period 1941 to 1980, by decade.*

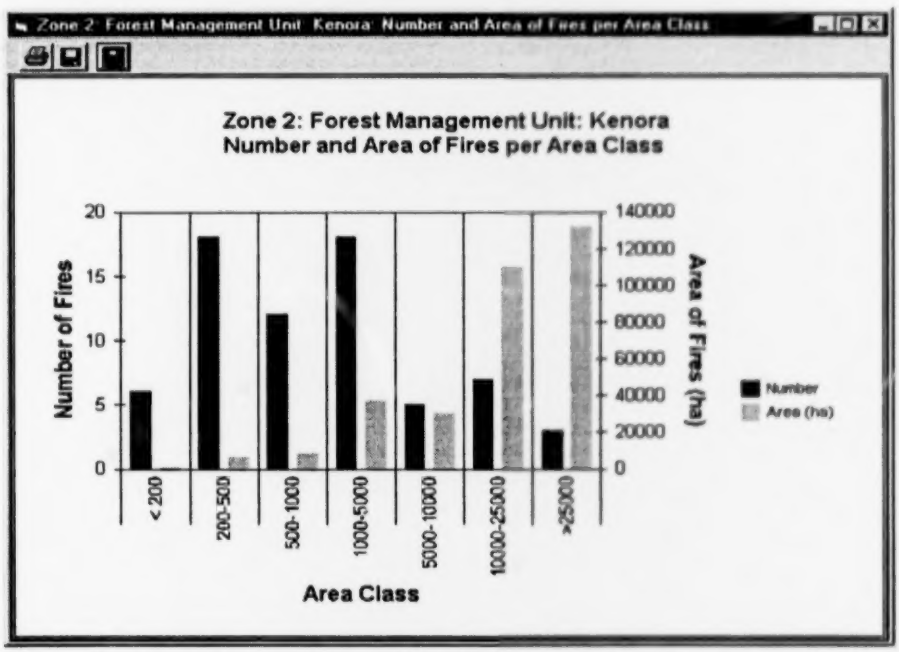


Figure 12. *The number and area of fires in the Kenora forest management unit, by size class.*

Fire Size-class Information

Historical fires can be also analyzed by their size-class. The size-class distribution is pre-set to < 200 ha, 200-500 ha, 500-1,000 ha, 1,000-5,000 ha, 5,000-10,000 ha, 10,000-15,000 ha, 15,000-25,000 ha, and >25,000 ha; but this can be changed by the user. An example of a size-class distribution summary is provided in Figure 12.

Another example of fire information summaries based on size class is given in Table 4, this one using the NTS map sheet template.

Percentage of Area Burned

The extent of historical forest fires can be assessed, based on percent of land area, using spatial and temporal templates. For example, Figure 13 shows the percentage of land area burned in Zone 2 for 1981 to 1995 for each Hill Site Region.

The cumulative percentage of burned area can be assessed over a period of years, as illustrated in the example from Zone 2, using the forest management unit template (Figure 14).

Surficial geology provides another spatial template that can be used to analyze the cumulative percentage of area burned. Figure 15 shows Site Region 3W in Zone 2.

Table 4. *Area of fires by size class and decade for NTS Map Sheet 53C in Zone 1.*

Area Class	1951-1960	1961-1970	1971-1980	1981-1990	1991-1995
< 200	0.0	333.0	33.4	747.8	243.4
200-500	0.0	1,336.1	2,855.5	4,677.3	0.0
500-1000	1,962.7	1,124.5	3,309.7	5,525.2	2,259.7
1000-5000	11,842.1	20,124.1	11,651.4	44,304.4	18,080.6
5000-10000	15,056.5	19,577.5	26,707.1	16,230.6	23,812.1
10000-15000	13,607.5	12,018.9	0.0	23,004.5	0.0
15000-25000	20,971.4	0.0	23,545.1	38,031.6	35,917.3
>25000	0.0	0.0	170,907.7	61,574.5	0.0

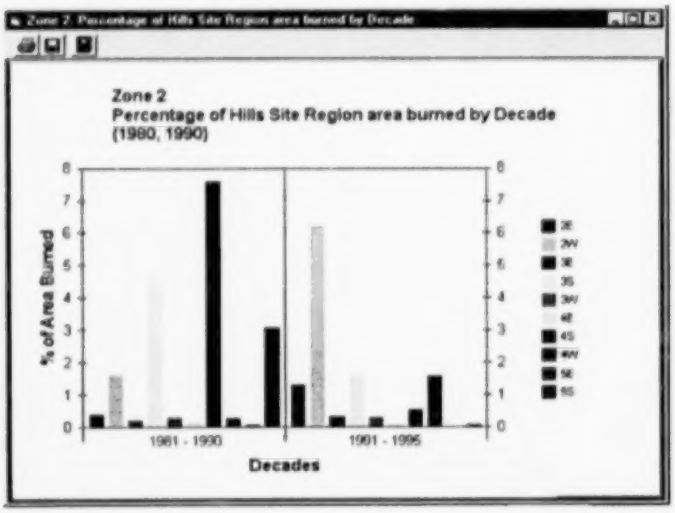


Figure 13. *The percentage of area burned, by Hills Site Region and decade, from 1981 to 1995.*

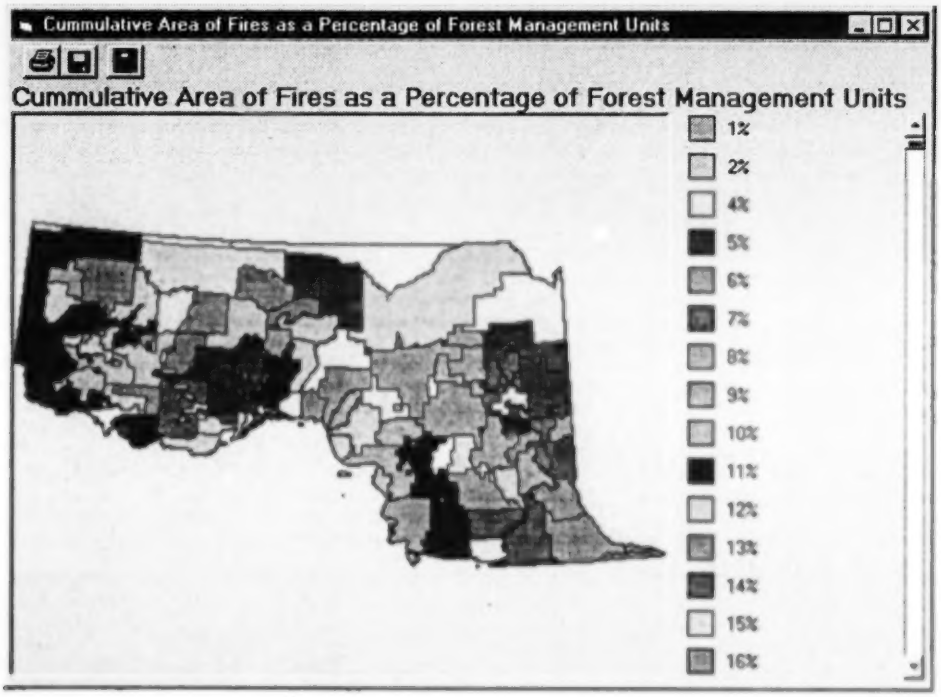


Figure 14. *Cumulative area of fires, as a percentage of land area in the forest management units of Zone 2, from 1921 to 1995.*

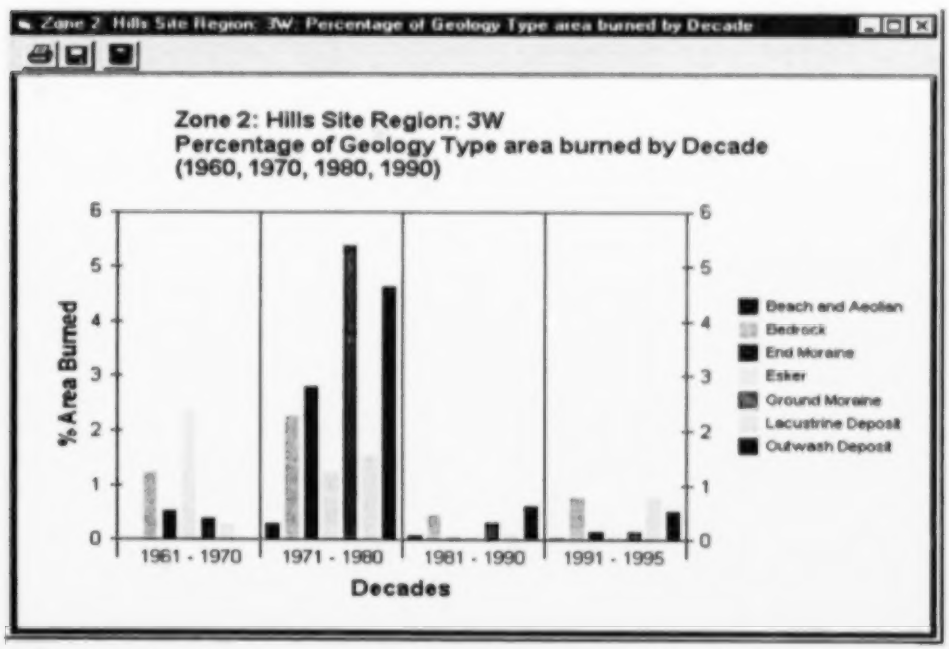


Figure 15. *Cumulative percentage of burned area by surficial geology type in Site Region 3W in Zone 2, by decade, from 1961 to 1995.*

USER'S GUIDE

This part of the report explains how to install and use the digital fire history atlas as well as outlines some of the assumptions and default settings and how to reset them.

Installation Instructions

The digital atlas software and data require approximately 32 MB of hard disk space. To install the atlas, place the distribution CD in your CD-ROM drive. Using Explorer, double-click on the 'setup.exe' file. Alternatively click on Start on the toolbar, then Run, and enter: x:\setup.exe (replace 'x' with the drive letter for your CD-ROM). Follow the instructions given on screen. The installation process will put both the software and data onto your computer.

Using the Digital Atlas

The Digital Atlas provides 2 main windows. In the *Selection Window* you select the area of the province for which you wish to display fires; the *Display Window* displays the fires for the selected area. The Display Window also contains the tool bar and provides access to all the functions and features of the program.

1. Using the Selection Window

When you start the Atlas, the Selection Window is displayed. It remains on screen for your entire session.

The Selection Window initially displays the entire province subdivided into the 3 zones (Zones 1, 2, and 3).

Using the Selection Window, choose the zone, region, district, forest management unit, and/or NTS map sheet you wish to view. These area-types are arranged in a hierarchy and selected in sequence. For example, to view a specific Hills District, first select the zone in which it occurs, then its Hills Region, and then the district itself.

To select a zone for analysis, click on the zone in the window or press the *down-level* button and select the zone from the menu. The Display Window will display fires in the selected zone.

To select a region-type for display (e.g., Hills Region), click on the down-level button and choose the region-type; you may also select management units or NTS map sheets.

The Selection Window will display the boundaries for the regions, identifying each region within the zone. Select a specific region by clicking on it. That region will be highlighted in the Selection Window and fires for the region will be displayed in the Display Window.

Depending on which region-type you select, you may further select other areas such as districts. For example, if you select a specific Hills Region, you may choose to view the Hills

Districts within the region. After selecting a specific region, press the down-level button and choose Hills District or management unit from the menu. The Selection Window will display the boundaries for the districts or units; select a specific district or unit by clicking on it.

To move up the display hierarchy, press the *up-level* button. For example, if you have selected a Hills Region and then a Hills District within that region, press the up-level button to return the Display Window to Hills Region; press up-level again to display zones.

To return the Display Window to the provincial view of the 3 zones, from anywhere in the display hierarchy, press the *province* button.

2. Using the Display Window

The Display Window shows the fires for the area of the province currently selected in the Selection Window. This window also contains the tool bar that provides access to the functions and features of the atlas.

2.1 Managing the Display

The digital atlas has several tools to help you manage the display.

To zoom into an image, press the *zoom-in* button. Move the cursor and click on the general area you wish to zoom in to. Alternatively, move the cursor to one corner of the area, press and hold the left mouse button while moving the cursor to the opposite corner, and release the button.

To zoom out of an image, press the *zoom-out* button or move the cursor over the image and press the left mouse button.

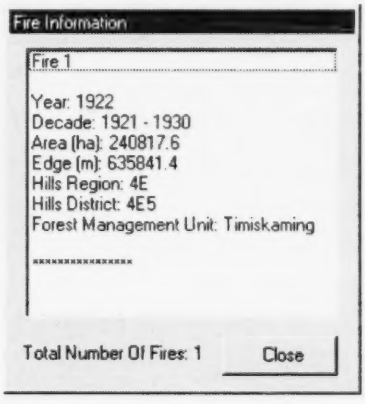
If an image is too large to fit into the Display Window, horizontal and vertical scroll bars are provided. You can also shift the image by pressing the *pan* button, moving the cursor over the image, then holding the left mouse button down while moving the mouse.

To return the display to the full image of the current zone, press the *full extent* button.

2.2 Displaying Fire Information

To display information about a specific fire, press the *fire information* button, move the cursor over the fire and press the left mouse button. The fire information dialog box will open to display information about the fire. To display information about another fire, click on it. If the point on which you have clicked has 2 or more overlapping fires, the fire information dialog box will display information for each fire separately. Use the scrollbar to shift the displayed text among the fires.

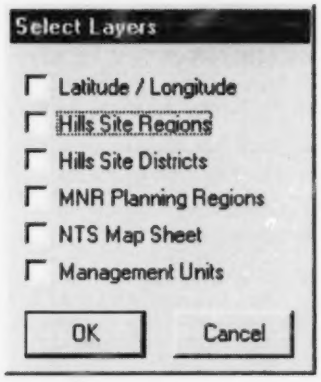
The dialog box will remain on screen until you close it by pressing the *close* button.



2.3 Overlaying Boundary Layers

You can overlay various boundary layers on the map image, including regions and districts, management units, and NTS map sheet boundaries.

To overlay a boundary layer, press the *select layer* button. The Select Layer dialog box will open; click on the check box of layers you wish to display. Press *OK* when done.



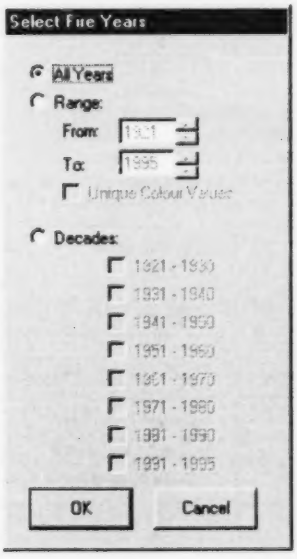
2.4 Selecting Fire Years and Decades

To display fires falling within a range of years or in particular decades, press the *select fire years* button. This will open the Select Fire Years dialog box.

To display all fires, click on the *all years* check box.

To display fires falling within a range of years, click on the *range* check box and enter the *from* and *to* year values. Click on the *unique colour values* check box to display fires with a different colour for each year.

To display fires occurring in specific decades, click on the *decades* check box. Click the check box beside each decade you wish to display. Only decades for which fire data are available in the current zone will be enabled. Fires will be displayed with a different colour for each selected decade.

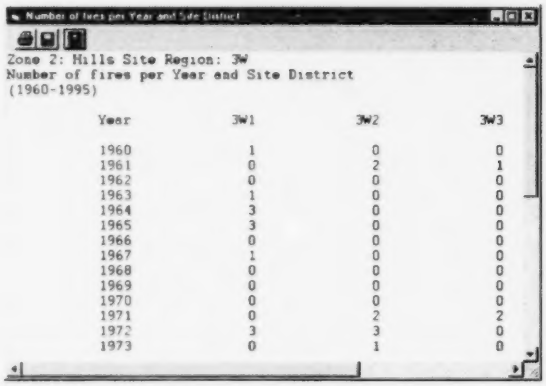


Press *OK* when you are done.

2.5. Displaying Tabular Summaries

The digital atlas allows you to display tabular summary information about the fires currently displayed in the Display Window. Press the *display table* button on the toolbar to get a drop-down menu of available tabular summaries. The available summaries will vary, depending on your current choice of area-types and fire years.

From the menu, click on the table you wish to view. A window will open displaying the summary information. The summary will be based on only those fires currently in the Display Window. If you change the selection of fires in the Display Window, you must open a new table to view the summary for those fires. Changing the selection of fires in the Display Window does not change the summary information in tables already displayed on screen.



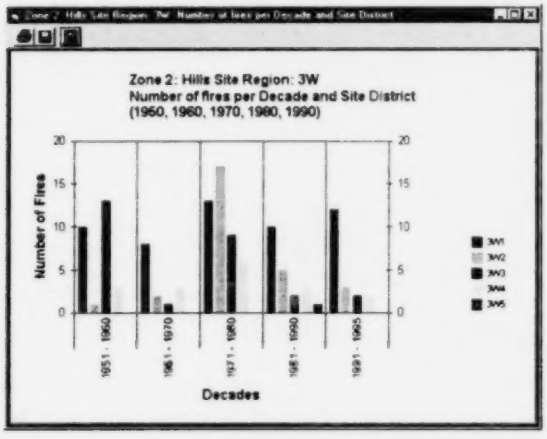
Zone 2: Hills Site Region: 3W
Number of fires per Year and Site District
(1960-1995)

Year	3W1	3W2	3W3
1960	1	0	0
1961	0	2	1
1962	0	0	0
1963	1	0	0
1964	3	0	0
1965	3	0	0
1966	0	0	0
1967	1	0	0
1968	0	0	0
1969	0	0	0
1970	0	0	0
1971	0	2	2
1972	3	3	0
1973	0	1	0

Each table is displayed in a separate window. You can open any number of tables at the same time. Each window has its own toolbar, allowing you to print the table, save the table to a text file, and close the window.

2.6 Displaying Chart Summaries

The digital atlas also allows you to display summary information in bar chart format. Press the *display chart* button on the toolbar to get a drop-down menu of available chart summaries. Click on the chart you wish to view.

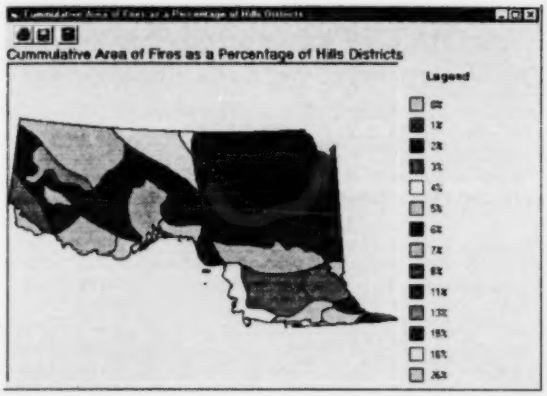


As with tabular summaries, a chart summary pertains only to the fires in the Display Window. If you change the selection of fires displayed, open a new chart to view the summary for those fires.

Each chart is displayed in a separate window. You can open any number of charts at the same time. Each window has its own toolbar, allowing you to print the chart, save the chart to a bitmap file, and close the window.

2.7 Displaying Cumulative Map Summaries

To display a map of the total cumulative area burned as a percentage of total land area, press the *display cumulative map* button on the toolbar. For each Site District of the current zone, the map indicates the cumulative percentage area burned. The values pertain only to the currently selected years or decades, and reflect the cumulative total up to the last year or decade.



2.8 Printing and Saving Maps

To print the map that is currently displayed in the Display Window, press the *print* button. Select the printer in the Select Printer dialog box and press *OK*.

You can also save the currently displayed map to a bitmap file. Press the *save* button, specify the bitmap file name in the Save As dialog box and press *OK*.

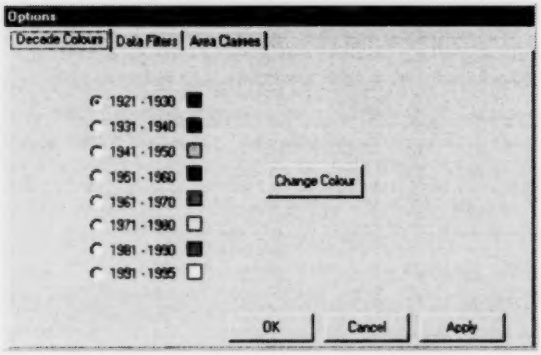
2.9 Displaying the Scale Bar

To display a scale bar over the Display Window, press the *tools* button and select the *scale bar* menu item. The scale bar will be displayed in a separate floating window that you can move around the display. To remove the scale bar, select the scale bar menu item again.

3. Setting Program Options

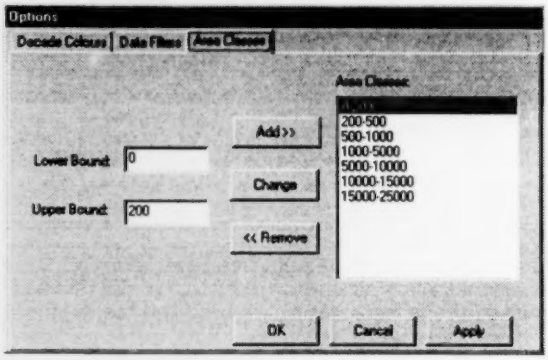
To set program options, open the Options dialog box by pressing the tools button and selecting the *option* menu item. Three sets of options are available: *decade colours, data filters,* and *area classes.*

When fires are displayed by decade, a different colour can be used to represent each decade; fires occurring in the same decade will have the same colour. To change the colour used to represent a decade, press the decade colours tab. Click on the decade you wish to change and press the *change colour* button. Select from the available basic colours, or create a custom colour by pressing the *define custom colors* button.



When displaying analyses for a Hills Site District or management unit within a selected Hills Site Region, you may generate results in 2 ways. In the first approach, all fires occurring within the district or unit are included in the analyses, whether or not they fall within the selected site region. In the second approach, a data filter is applied that excludes fires not falling within the selected region from the analyses of districts and units within it. By default, the first approach is used; the analysis of a district or unit includes all fires within it. To use the second approach, press the data filters tab and check the *filter results by current region* check box.

By default, summaries of fire area do not include the area of associated water bodies they contain. To include the area of water in the summaries of fire areas, press the data filters tab and uncheck the *remove area of water from results* check box.



To adjust the number and width of area classes that are used in analyses of size-class distribution, press the area classes tab. The list of current area classes will be displayed in the dialog box. To add an area class, enter the lower and upper bounds of the class and press the *Add* button. To remove an area class from the list, click on the class and press the *Remove* button. To change an existing class, click on the class in the list, modify the lower and/or upper bounds as required, and press the *Change* button.

4. Exiting the Digital Atlas

To close all open windows and exit the digital atlas, press the *exit* button on the toolbar of the Display Window.

REFERENCES

Donnelly, R.E. and J.B. Harrington. 1978. Forest fire history maps of Ontario. Canadian Forestry Service. Miscellaneous Report FF-Y-6.

Hills, G. A. 1959. A ready reference to the description of the land of Ontario and its productivity. Ontario Department of Lands and Forests. Maple, Ontario. Preliminary Report. 140 p.

Perera A.H., Laguna, J., Baldwin, D.J.B., Godschalk, H., Ouellette, M. and S. Pala. 1996. Surficial geology of Ontario: A digital database. Ontario Ministry of Natural Resources, Ontario Forest Research Institute, Forest Fragmentation and Biodiversity Report Series #22.

Spectranalysis Inc. (1994) Age classification of cutovers and burns and ground access route mapping in northwestern and north-central Ontario. Spectranalysis Inc. Internal mimeograph. 17 p.

APPENDIX I - Digital Atlas Data Files and Directory Structures

The data used directly by the atlas is installed in the following data files and directories on your hard-drive as part of the installation process. In the examples, "$root" refers the base directory name under which the atlas is installed (e.g., "C:\Program Files\Ontario's Forest Fire History").

- Spatial fire data is stored in the following Shapefiles:

  Firedata.dbf
  Firedata.shp
  Firedata.shx

  There is one Shapefile for each zone, stored in the directories:

  $root\Data\Zone1
  $root\Data\Zone2
  $root\Data\Zone3

- Fire attribute data is stored in a Microsoft Access database, with separate databases for each zone:

  $root\Database\Zone1\Fireattr.mdb
  $root\Database\Zone2\Fireattr.mdb
  $root\Database\Zone2\Fireattr.mdb

  These files are password-protected and cannot be opened directly with Access unless the password is provided (contact the Forest Landscape Ecology Program at the Ontario Forest Research Institute if you wish to access this data).

- Spatial templates are stored in the following Shapefiles:

  Elup_reg.shp
  Hill_reg.shp
  Hilldist.shp
  Mgt_unit.shp
  Nts_map.shp

  A corresponding *.dbf and a *.shx file exists for each *.shp file. There is one set of template shapefiles for each zone, stored in the directories:

  $root\Layers\Zone1
  $root\Layers\Zone2
  $root\Layers\Zone3

  These directories contain additional Shapefiles with template name and label information.

The original fire data is stored in Arc/Info coverages on the CD-ROM, but will not be installed on your hard-drive. The data are bundled in the self-extracting archive file "Rawdata.exe", stored in the directory "x:\Rawdata" (where x is the letter designating your CD-ROM drive). This file is password-protected (contact the Forest Landscape Ecology Program at the Ontario Forest Research Institute to access this data).

The following data files are stored in the archive:

fire_zn1.mdb (fire attribute data for Zone 1)
fire_zn2.mdb (fire attribute data for Zone 2)
fire_zn3.mdb (fire attribute data for Zone 3)
firedata.e00 (coverage of all fires)
firezone.e00 (coverage of zone boundaries)
GisData.prj (projection information)
hilldist.e00 (coverage of Hills Site District boundaries)
hillreg.e00 (coverage of Hills Site Region boundaries)
mgtunit.e00 (coverage of management unit boundaries)
ntssheet.e00 (coverage of NTS map sheet boundaries)
planning.e00 (coverage of OMNR planning regions)

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